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INSTRUCTIONS FOR USE OF THE DIFFERENTIAL DYE TEST  
FOR ESTIMATING MATURITY OF COTTON<sup>1/</sup>

Preparation of samples. Samples of cotton are carefully selected to be representative of the entire lots of raw stock. It is preferable, for comparative purposes, to dye all of the samples in the same bath at the same time. A convenient weight of sample is 3 to 5 grams. If only one sample is to be dyed, it is loosely enclosed in a small bag made from bleached open-mesh gauze (28 x 24 thread count). If a number of samples are to be dyed, a convenient arrangement for handling throughout treatment is to place 4 to 6 of the samples within gauze, about 5 x 18 inches. A seam is sewed around each sample to keep it separate. Any practicable number of such strips can be dyed simultaneously.

Identification of samples. A coding system is used to identify the prepared strips and the samples within each strip. The system is based upon the number and the position of knots tied in a cotton cord attached at the end of the strip. The number of knots in either or both ends of the cord differentiates between different strips. The position of the sample with respect to the end at which the cord is attached identifies individual samples within each strip.

Apparatus and materials. The differential dye test can be made with conventional laboratory apparatus. Two commercial direct dyestuffs are required: Diphenyl Fast Red 5BL Supra I (Geigy) (C. I. No. 278) and Chlorantine Fast Green BLL (Ciba) (Prototype 425). Stock solutions of the dyes are used having concentrations of 5 grams per liter for the red and 10 grams per liter for the green.

The sodium chloride required for the dyebath is made up for convenience into a solution containing 10 grams per liter.

Method. After weighing, the cotton is entered without prewetting into a boiling bath, made up with distilled water to 40 times the weight of cotton, containing 1.2% red dye and 2.8% green dye, calculated on the weight of all the cotton, samples plus gauze. The samples are kept submerged until thoroughly wetted.

After dyeing for 15 minutes at the boil the cotton is lifted out and 2-1/2% of its weight of C. P. sodium chloride is stirred into the dyebath. The required quantity of salt is added in the form of a 1% solution in order to compensate for the reduction of the dyebath caused by evaporation.

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<sup>1/</sup> Report of a study made under the Research and Marketing Act of 1946.







The cotton is re-entered for 15 minutes, then lifted again, and a second portion of 2-1/2% sodium chloride is added. The dyeing proceeds at the boil to a total of 45 minutes when the cotton is lifted, squeezed, cooled, and washed well in two changes of cold, distilled water in the proportion of 50 parts to 1 of cotton. After squeezing out of excess water, the matted fibers are pulled apart while still in the gauze and are dipped into vigorously boiling water (50:1) for exactly 30 seconds, with stirring, then lifted, and the excess liquor is removed as rapidly as possible: for example, by squeezing in a hand wringer, centrifuging, or pressing on a wire screen. The time of contact of the dyed material with the boiling water is very critical with respect to the final shade; and variations in this manipulation are chiefly responsible for inaccuracies in the reproduction of dyeings. For best results it is advisable to handle each strip separately for this operation to insure rapid and uniform removal of the hot water. The hot washing is not in accordance with usual direct dyeing practice and is really a differential stripping. It removes excess red dye but relatively little green, thus eliminating grayness and resulting in more clearly defined colors, especially the green.

After final wringing the dyeings are removed from the gauze bags, fluffed, and allowed to dry in the open air or with moderate heat. Mature cotton in its natural state will have colored to a pronounced red. Thin-walled or immature cotton will be gray-green to a distinct green.

Close attention to all details is recommended, although extensive experience may indicate that the procedure can be simplified somewhat without detracting from the results. It is advisable, however, to use the exact dyes specified and to use distilled water for all solutions and for the dyeing. Slight variations between different lots of the same dye may cause less than the optimum contrast in color obtained, and necessitate revision of the formula.

Estimation of maturity by color. The absolute or relative maturity is determined from the overall color of the dyed sample, the reddest being of greatest maturity. The natural occurrence of differently colored tufts of fibers in a raw stock sample makes critical comparison difficult. A simple and effective method of obtaining a uniform shade is to cut the sample (about 3 grams) to a near powder (20-mesh screen) in a Wiley mill. The cut cotton is then dispersed in a 40:1 volume of water containing 1% of an adhesive (sodium carboxymethyl cellulose) and filtered by suction on an 80-mm. coarse fritted disc funnel. The cotton is removed from the funnel by air pressure and dried in the form of a smooth flat pad. A gummed label is placed on the rough side for identification of the sample. A series of such pads can usually be placed in order of color or maturity by visual examination or the percentage maturity estimated by comparisons with a suitable color scale calibrated in terms of maturity.





Sources of Supply of Chemicals and Apparatus Used with the  
Differential Dye Test<sup>2/</sup>

Chemicals and supplies:

Diphenyl F. Red 5BL (Supra I): Geigy Co., Inc., 89-91 Barclay St.,  
New York, N. Y.  
Chlorantine F. Green BLL: Ciba Co., Inc., 627 Greenwich St.,  
New York 14, N. Y.  
Sodium chloride C. P.: Any chemical supply company.  
Sodium carboxymethyl cellulose (low viscosity) ("Carbose D"),  
Wyandotte Chem. Corp., Wyandotte, Mich.  
Bleached 28 x 24 gauze and cotton cord.

Apparatus:

Beakers, preferably stainless steel. Capacities: 400 ml., 1200 ml.,  
2000 ml., and 3300 ml.: Harshaw Chemical Co., 244 Main St.,  
Cincinnati, Ohio.  
Hotplate (1200 watt): Any chemical supply company.  
Triple beam balance (cap. 1011 grams sensitivity 5 cg.): Central  
Scientific Co., 1700 Irving Park Road, Chicago 13, Ill.  
Scissors, needle, and thread, or sewing machine, household-type.  
Beaker tongs and crucible tongs.  
Stirring rods and spatulas or spoons.  
Graduated cylinders - 5, 10, 25, 50, 100 and 500 ml.: or automatic  
burettes (screw-top-acid bottle-type, 100 ml. capacity in 1-ml.  
graduations): Harshaw Chemical Co., 244 Main St., Cincinnati, Ohio.  
Timer (with second hand) or stop watch.  
Coarse fritted-disc filter funnel, Buchner type, 150 ml. capacity with  
suction flask: Any chemical supply company.  
Laboratory Wiley Mill (Intermediate Model): Arthur S. LaPine & Co.,  
121 W. Hubbard St., Chicago 10, Ill.  
Clothes wringer; or centrifuge.

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<sup>2/</sup> The mention of trade products does not imply that they are endorsed  
or recommended by the Department of Agriculture over similar products not  
mentioned.



Source of supply of chemicals and apparatus used with the  
in the laboratory of the

Chemicals and apparatus

Reagents: 1. Red 2. Green 3. Blue 4. Yellow 5. Orange 6. Purple 7. Brown 8. Black 9. White 10. Grey 11. Silver 12. Gold 13. Copper 14. Iron 15. Zinc 16. Lead 17. Tin 18. Nickel 19. Cobalt 20. Manganese 21. Potassium 22. Sodium 23. Calcium 24. Magnesium 25. Barium 26. Strontium 27. Bismuth 28. Antimony 29. Arsenic 30. Selenium 31. Tellurium 32. Iodine 33. Bromine 34. Chlorine 35. Fluorine 36. Oxygen 37. Nitrogen 38. Hydrogen 39. Carbon 40. Silicon 41. Boron 42. Phosphorus 43. Sulfur 44. Molybdenum 45. Vanadium 46. Chromium 47. Manganese 48. Iron 49. Cobalt 50. Nickel 51. Copper 52. Zinc 53. Cadmium 54. Barium 55. Strontium 56. Calcium 57. Magnesium 58. Potassium 59. Sodium 60. Lithium 61. Rubidium 62. Cesium 63. Francium 64. Actinium 65. Thorium 66. Radium 67. Polonium 68. Astatine 69. Tellurium 70. Iodine 71. Bromine 72. Chlorine 73. Fluorine 74. Oxygen 75. Nitrogen 76. Carbon 77. Silicon 78. Boron 79. Phosphorus 80. Sulfur 81. Selenium 82. Tellurium 83. Molybdenum 84. Vanadium 85. Chromium 86. Manganese 87. Iron 88. Cobalt 89. Nickel 90. Copper 91. Zinc 92. Cadmium 93. Barium 94. Strontium 95. Calcium 96. Magnesium 97. Potassium 98. Sodium 99. Lithium 100. Rubidium 101. Cesium 102. Francium 103. Actinium 104. Thorium 105. Radium 106. Polonium 107. Astatine 108. Tellurium 109. Iodine 110. Bromine 111. Chlorine 112. Fluorine 113. Oxygen 114. Nitrogen 115. Carbon 116. Silicon 117. Boron 118. Phosphorus 119. Sulfur 120. Selenium 121. Tellurium 122. Molybdenum 123. Vanadium 124. Chromium 125. Manganese 126. Iron 127. Cobalt 128. Nickel 129. Copper 130. Zinc 131. Cadmium 132. Barium 133. Strontium 134. Calcium 135. Magnesium 136. Potassium 137. Sodium 138. Lithium 139. Rubidium 140. Cesium 141. Francium 142. Actinium 143. Thorium 144. Radium 145. Polonium 146. Astatine 147. Tellurium 148. Iodine 149. Bromine 150. Chlorine 151. Fluorine 152. Oxygen 153. Nitrogen 154. Carbon 155. Silicon 156. Boron 157. Phosphorus 158. Sulfur 159. Selenium 160. Tellurium 161. Molybdenum 162. Vanadium 163. Chromium 164. Manganese 165. Iron 166. Cobalt 167. Nickel 168. Copper 169. Zinc 170. Cadmium 171. Barium 172. Strontium 173. Calcium 174. Magnesium 175. Potassium 176. Sodium 177. Lithium 178. Rubidium 179. Cesium 180. Francium 181. Actinium 182. Thorium 183. Radium 184. Polonium 185. Astatine 186. Tellurium 187. Iodine 188. Bromine 189. Chlorine 190. Fluorine 191. Oxygen 192. Nitrogen 193. Carbon 194. Silicon 195. Boron 196. Phosphorus 197. Sulfur 198. Selenium 199. Tellurium 200. Molybdenum 201. Vanadium 202. Chromium 203. Manganese 204. Iron 205. Cobalt 206. Nickel 207. Copper 208. Zinc 209. Cadmium 210. Barium 211. Strontium 212. Calcium 213. Magnesium 214. Potassium 215. Sodium 216. Lithium 217. Rubidium 218. Cesium 219. Francium 220. Actinium 221. Thorium 222. Radium 223. Polonium 224. Astatine 225. Tellurium 226. Iodine 227. Bromine 228. Chlorine 229. Fluorine 230. Oxygen 231. Nitrogen 232. Carbon 233. Silicon 234. Boron 235. Phosphorus 236. Sulfur 237. Selenium 238. Tellurium 239. Molybdenum 240. Vanadium 241. Chromium 242. Manganese 243. Iron 244. Cobalt 245. Nickel 246. Copper 247. Zinc 248. Cadmium 249. Barium 250. Strontium 251. Calcium 252. Magnesium 253. Potassium 254. Sodium 255. Lithium 256. Rubidium 257. Cesium 258. Francium 259. Actinium 260. Thorium 261. Radium 262. Polonium 263. Astatine 264. Tellurium 265. Iodine 266. Bromine 267. Chlorine 268. Fluorine 269. Oxygen 270. Nitrogen 271. Carbon 272. Silicon 273. Boron 274. Phosphorus 275. Sulfur 276. Selenium 277. Tellurium 278. Molybdenum 279. Vanadium 280. Chromium 281. Manganese 282. Iron 283. Cobalt 284. Nickel 285. Copper 286. Zinc 287. Cadmium 288. Barium 289. Strontium 290. Calcium 291. Magnesium 292. Potassium 293. Sodium 294. Lithium 295. Rubidium 296. Cesium 297. Francium 298. Actinium 299. Thorium 300. Radium 301. Polonium 302. Astatine 303. Tellurium 304. Iodine 305. Bromine 306. Chlorine 307. Fluorine 308. Oxygen 309. Nitrogen 310. Carbon 311. Silicon 312. Boron 313. Phosphorus 314. Sulfur 315. Selenium 316. Tellurium 317. Molybdenum 318. Vanadium 319. Chromium 320. Manganese 321. Iron 322. Cobalt 323. Nickel 324. Copper 325. Zinc 326. Cadmium 327. Barium 328. Strontium 329. Calcium 330. Magnesium 331. Potassium 332. Sodium 333. Lithium 334. Rubidium 335. Cesium 336. Francium 337. Actinium 338. Thorium 339. Radium 340. Polonium 341. Astatine 342. Tellurium 343. Iodine 344. Bromine 345. Chlorine 346. Fluorine 347. Oxygen 348. Nitrogen 349. Carbon 350. Silicon 351. Boron 352. Phosphorus 353. Sulfur 354. Selenium 355. Tellurium 356. Molybdenum 357. Vanadium 358. Chromium 359. Manganese 360. Iron 361. Cobalt 362. Nickel 363. Copper 364. Zinc 365. Cadmium 366. Barium 367. Strontium 368. Calcium 369. Magnesium 370. Potassium 371. Sodium 372. Lithium 373. Rubidium 374. Cesium 375. Francium 376. Actinium 377. Thorium 378. Radium 379. Polonium 380. Astatine 381. Tellurium 382. Iodine 383. Bromine 384. Chlorine 385. Fluorine 386. Oxygen 387. Nitrogen 388. Carbon 389. Silicon 390. Boron 391. Phosphorus 392. Sulfur 393. Selenium 394. Tellurium 395. Molybdenum 396. Vanadium 397. Chromium 398. Manganese 399. Iron 400. Cobalt 401. Nickel 402. Copper 403. Zinc 404. Cadmium 405. Barium 406. Strontium 407. Calcium 408. Magnesium 409. Potassium 410. Sodium 411. Lithium 412. Rubidium 413. Cesium 414. Francium 415. Actinium 416. Thorium 417. Radium 418. Polonium 419. Astatine 420. Tellurium 421. Iodine 422. Bromine 423. Chlorine 424. Fluorine 425. Oxygen 426. Nitrogen 427. Carbon 428. Silicon 429. Boron 430. Phosphorus 431. Sulfur 432. Selenium 433. Tellurium 434. Molybdenum 435. Vanadium 436. Chromium 437. Manganese 438. Iron 439. Cobalt 440. Nickel 441. Copper 442. Zinc 443. Cadmium 444. Barium 445. Strontium 446. Calcium 447. Magnesium 448. Potassium 449. Sodium 450. Lithium 451. Rubidium 452. Cesium 453. Francium 454. Actinium 455. Thorium 456. Radium 457. Polonium 458. Astatine 459. Tellurium 460. Iodine 461. Bromine 462. Chlorine 463. Fluorine 464. Oxygen 465. Nitrogen 466. Carbon 467. Silicon 468. Boron 469. Phosphorus 470. Sulfur 471. Selenium 472. Tellurium 473. Molybdenum 474. Vanadium 475. Chromium 476. Manganese 477. Iron 478. Cobalt 479. Nickel 480. Copper 481. Zinc 482. Cadmium 483. Barium 484. Strontium 485. Calcium 486. Magnesium 487. Potassium 488. Sodium 489. Lithium 490. Rubidium 491. Cesium 492. Francium 493. Actinium 494. Thorium 495. Radium 496. Polonium 497. Astatine 498. Tellurium 499. Iodine 500. Bromine 501. Chlorine 502. Fluorine 503. Oxygen 504. Nitrogen 505. Carbon 506. Silicon 507. Boron 508. Phosphorus 509. Sulfur 510. Selenium 511. Tellurium 512. Molybdenum 513. Vanadium 514. Chromium 515. Manganese 516. Iron 517. Cobalt 518. Nickel 519. Copper 520. Zinc 521. Cadmium 522. Barium 523. Strontium 524. Calcium 525. Magnesium 526. Potassium 527. Sodium 528. Lithium 529. Rubidium 530. Cesium 531. Francium 532. Actinium 533. Thorium 534. Radium 535. Polonium 536. Astatine 537. Tellurium 538. Iodine 539. Bromine 540. Chlorine 541. Fluorine 542. Oxygen 543. Nitrogen 544. Carbon 545. Silicon 546. Boron 547. Phosphorus 548. Sulfur 549. Selenium 550. Tellurium 551. Molybdenum 552. Vanadium 553. Chromium 554. Manganese 555. Iron 556. Cobalt 557. Nickel 558. Copper 559. Zinc 560. Cadmium 561. Barium 562. Strontium 563. Calcium 564. Magnesium 565. Potassium 566. Sodium 567. Lithium 568. Rubidium 569. Cesium 570. Francium 571. Actinium 572. Thorium 573. Radium 574. Polonium 575. Astatine 576. Tellurium 577. Iodine 578. Bromine 579. Chlorine 580. Fluorine 581. Oxygen 582. Nitrogen 583. Carbon 584. Silicon 585. Boron 586. Phosphorus 587. Sulfur 588. Selenium 589. Tellurium 590. Molybdenum 591. Vanadium 592. Chromium 593. Manganese 594. Iron 595. Cobalt 596. Nickel 597. Copper 598. Zinc 599. Cadmium 600. Barium 601. Strontium 602. Calcium 603. Magnesium 604. Potassium 605. Sodium 606. Lithium 607. Rubidium 608. Cesium 609. Francium 610. Actinium 611. Thorium 612. Radium 613. Polonium 614. Astatine 615. Tellurium 616. Iodine 617. Bromine 618. Chlorine 619. Fluorine 620. Oxygen 621. Nitrogen 622. Carbon 623. Silicon 624. Boron 625. Phosphorus 626. Sulfur 627. Selenium 628. Tellurium 629. Molybdenum 630. Vanadium 631. Chromium 632. Manganese 633. Iron 634. Cobalt 635. Nickel 636. Copper 637. Zinc 638. Cadmium 639. Barium 640. Strontium 641. Calcium 642. Magnesium 643. Potassium 644. Sodium 645. Lithium 646. Rubidium 647. Cesium 648. Francium 649. Actinium 650. Thorium 651. Radium 652. Polonium 653. Astatine 654. Tellurium 655. Iodine 656. Bromine 657. Chlorine 658. Fluorine 659. Oxygen 660. Nitrogen 661. Carbon 662. Silicon 663. Boron 664. Phosphorus 665. Sulfur 666. Selenium 667. Tellurium 668. Molybdenum 669. Vanadium 670. Chromium 671. Manganese 672. Iron 673. Cobalt 674. Nickel 675. Copper 676. Zinc 677. Cadmium 678. Barium 679. Strontium 680. Calcium 681. Magnesium 682. Potassium 683. Sodium 684. Lithium 685. Rubidium 686. Cesium 687. Francium 688. Actinium 689. Thorium 690. Radium 691. Polonium 692. Astatine 693. Tellurium 694. Iodine 695. Bromine 696. Chlorine 697. Fluorine 698. Oxygen 699. Nitrogen 700. Carbon 701. Silicon 702. Boron 703. Phosphorus 704. Sulfur 705. Selenium 706. Tellurium 707. Molybdenum 708. Vanadium 709. Chromium 710. Manganese 711. Iron 712. Cobalt 713. Nickel 714. Copper 715. Zinc 716. Cadmium 717. Barium 718. Strontium 719. Calcium 720. Magnesium 721. Potassium 722. Sodium 723. Lithium 724. Rubidium 725. Cesium 726. Francium 727. Actinium 728. Thorium 729. Radium 730. Polonium 731. Astatine 732. Tellurium 733. Iodine 734. Bromine 735. Chlorine 736. Fluorine 737. Oxygen 738. Nitrogen 739. Carbon 740. Silicon 741. Boron 742. Phosphorus 743. Sulfur 744. Selenium 745. Tellurium 746. Molybdenum 747. Vanadium 748. Chromium 749. Manganese 750. Iron 751. Cobalt 752. Nickel 753. Copper 754. Zinc 755. Cadmium 756. Barium 757. Strontium 758. Calcium 759. Magnesium 760. Potassium 761. Sodium 762. Lithium 763. Rubidium 764. Cesium 765. Francium 766. Actinium 767. Thorium 768. Radium 769. Polonium 770. Astatine 771. Tellurium 772. Iodine 773. Bromine 774. Chlorine 775. Fluorine 776. Oxygen 777. Nitrogen 778. Carbon 779. Silicon 780. Boron 781. Phosphorus 782. Sulfur 783. Selenium 784. Tellurium 785. Molybdenum 786. Vanadium 787. Chromium 788. Manganese 789. Iron 790. Cobalt 791. Nickel 792. Copper 793. Zinc 794. Cadmium 795. Barium 796. Strontium 797. Calcium 798. Magnesium 799. Potassium 800. Sodium 801. Lithium 802. Rubidium 803. Cesium 804. Francium 805. Actinium 806. Thorium 807. Radium 808. Polonium 809. Astatine 810. Tellurium 811. Iodine 812. Bromine 813. Chlorine 814. Fluorine 815. Oxygen 816. Nitrogen 817. Carbon 818. Silicon 819. Boron 820. Phosphorus 821. Sulfur 822. Selenium 823. Tellurium 824. Molybdenum 825. Vanadium 826. Chromium 827. Manganese 828. Iron 829. Cobalt 830. Nickel 831. Copper 832. Zinc 833. Cadmium 834. Barium 835. Strontium 836. Calcium 837. Magnesium 838. Potassium 839. Sodium 840. Lithium 841. Rubidium 842. Cesium 843. Francium 844. Actinium 845. Thorium 846. Radium 847. Polonium 848. Astatine 849. Tellurium 850. Iodine 851. Bromine 852. Chlorine 853. Fluorine 854. Oxygen 855. Nitrogen 856. Carbon 857. Silicon 858. Boron 859. Phosphorus 860. Sulfur 861. Selenium 862. Tellurium 863. Molybdenum 864. Vanadium 865. Chromium 866. Manganese 867. Iron 868. Cobalt 869. Nickel 870. Copper 871. Zinc 872. Cadmium 873. Barium 874. Strontium 875. Calcium 876. Magnesium 877. Potassium 878. Sodium 879. Lithium 880. Rubidium 881. Cesium 882. Francium 883. Actinium 884. Thorium 885. Radium 886. Polonium 887. Astatine 888. Tellurium 889. Iodine 890. Bromine 891. Chlorine 892. Fluorine 893. Oxygen 894. Nitrogen 895. Carbon 896. Silicon 897. Boron 898. Phosphorus 899. Sulfur 900. Selenium 901. Tellurium 902. Molybdenum 903. Vanadium 904. Chromium 905. Manganese 906. Iron 907. Cobalt 908. Nickel 909. Copper 910. Zinc 911. Cadmium 912. Barium 913. Strontium 914. Calcium 915. Magnesium 916. Potassium 917. Sodium 918. Lithium 919. Rubidium 920. Cesium 921. Francium 922. Actinium 923. Thorium 924. Radium 925. Polonium 926. Astatine 927. Tellurium 928. Iodine 929. Bromine 930. Chlorine 931. Fluorine 932. Oxygen 933. Nitrogen 934. Carbon 935. Silicon 936. Boron 937. Phosphorus 938. Sulfur 939. Selenium 940. Tellurium 941. Molybdenum 942. Vanadium 943. Chromium 944. Manganese 945. Iron 946. Cobalt 947. Nickel 948. Copper 949. Zinc 950. Cadmium 951. Barium 952. Strontium 953. Calcium 954. Magnesium 955. Potassium 956. Sodium 957. Lithium 958. Rubidium 959. Cesium 960. Francium 961. Actinium 962. Thorium 963. Radium 964. Polonium 965. Astatine 966. Tellurium 967. Iodine 968. Bromine 969. Chlorine 970. Fluorine 971. Oxygen 972. Nitrogen 973. Carbon 974. Silicon 975. Boron 976. Phosphorus 977. Sulfur 978. Selenium 979. Tellurium 980. Molybdenum 981. Vanadium 982. Chromium 983. Manganese 984. Iron 985. Cobalt 986. Nickel 987. Copper 988. Zinc 989. Cadmium 990. Barium 991. Strontium 992. Calcium 993. Magnesium 994. Potassium 995. Sodium 996. Lithium 997. Rubidium 998. Cesium 999. Francium 1000. Actinium 1001. Thorium 1002. Radium 1003. Polonium 1004. Astatine 1005. Tellurium 1006. Iodine 1007. Bromine 1008. Chlorine 1009. Fluorine 1010. Oxygen 1011. Nitrogen 1012. Carbon 1013. Silicon 1014. Boron 1015. Phosphorus 1016. Sulfur 1017. Selenium 1018. Tellurium 1019. Molybdenum 1020. Vanadium 1021. Chromium 1022. Manganese 1023. Iron 1024. Cobalt 1025. Nickel 1026. Copper 1027. Zinc 1028. Cadmium 1029. Barium 1030. Strontium 1031. Calcium 1032. Magnesium 1033. Potassium 1034. Sodium 1035. Lithium 1036. Rubidium 1037. Cesium 1038. Francium 1039. Actinium 1040. Thorium 1041. Radium 1042. Polonium 1043. Astatine 1044. Tellurium 1045. Iodine 1046. Bromine 1047. Chlorine 1048. Fluorine 1049. Oxygen 1050. Nitrogen 1051. Carbon 1052. Silicon 1053. Boron 1054. Phosphorus 1055. Sulfur 1056. Selenium 1057. Tellurium 1058. Molybdenum 1059. Vanadium 1060. Chromium 1061. Manganese 1062. Iron 1063. Cobalt 1064. Nickel 1065. Copper 1066. Zinc 1067. Cadmium 1068. Barium 1069. Strontium 1070. Calcium 1071. Magnesium 1072. Potassium 1073. Sodium 1074. Lithium 1075. Rubidium 1076. Cesium 1077. Francium 1078. Actinium 1079. Thorium 1080. Radium 1081. Polonium 1082. Astatine 1083. Tellurium 1084. Iodine 1085. Bromine 1086. Chlorine 1087. Fluorine 1088. Oxygen 1089. Nitrogen 1090. Carbon 1091. Silicon 1092. Boron 1093. Phosphorus 1094. Sulfur 1095. Selenium 1096. Tellurium 1097. Molybdenum 1098. Vanadium 1099. Chromium 1100. Manganese 1101. Iron 1102. Cobalt 1103. Nickel 1104. Copper 1105. Zinc 1106. Cadmium 1107. Barium 1108. Strontium 1109. Calcium 1110. Magnesium 1111. Potassium 1112. Sodium 1113. Lithium 1114. Rubidium 1115. Cesium 1116. Francium 1117. Actinium 1118. Thorium 1119. Radium 1120. Polonium 1121. Astatine 1122. Tellurium 1123. Iodine 1124. Bromine 1125. Chlorine 1126. Fluorine 1127. Oxygen 1128. Nitrogen 1129. Carbon 1130. Silicon 1131. Boron 1132. Phosphorus 1133. Sulfur 1134. Selenium 1135. Tellurium 1136. Molybdenum 1137. Vanadium 1138. Chromium 1139. Manganese 1140. Iron 1141. Cobalt 1142. Nickel 1143. Copper 1144. Zinc 1145. Cadmium 1146. Barium 1147. Strontium 1148. Calcium 1149. Magnesium 1150. Potassium 1151. Sodium 1152. Lithium 1153. Rubidium 1154. Cesium 1155. Francium 1156. Actinium 1157. Thorium 1158. Radium 1159. Polonium 1160. Astatine 1161. Tellurium 1162. Iodine 1163. Bromine 1164. Chlorine 1165. Fluorine 1166. Oxygen 1167. Nitrogen 1168. Carbon 1169. Silicon 1170. Boron 1171. Phosphorus 1172. Sulfur 1173. Selenium 1174. Tellurium 1175. Molybdenum 1176. Vanadium 1177. Chromium 1178. Manganese 1179. Iron 1180. Cobalt 1181. Nickel 1182. Copper 1183. Zinc 1184. Cadmium 1185. Barium 1186. Strontium 1187. Calcium 1188. Magnesium 1189. Potassium 1190. Sodium 1191. Lithium 1192. Rubidium 1193. Cesium 1194. Francium 1195. Actinium 1196. Thorium 1197. Radium 1198. Polonium 1199. Astatine 1200. Tellurium 1201. Iodine 1202. Bromine 1203. Chlorine 1204. Fluorine 1205. Oxygen 1206. Nitrogen 1207. Carbon 1208. Silicon 1209. Boron 1210. Phosphorus 1211. Sulfur 1212. Selenium 1213. Tellurium 1214. Molybdenum 1215. Vanadium 1216. Chromium 1217. Manganese 1218. Iron 1219. Cobalt 1220. Nickel 1221. Copper 1222. Zinc 1223. Cadmium 1224. Barium 1225. Strontium 1226. Calcium 1227. Magnesium 1228. Potassium 1229. Sodium 1230. Lithium 1231. Rubidium 1232. Cesium 1233. Francium 1234. Actinium 1235. Thorium 1236. Radium 1237. Polonium 1238. Astatine 1239. Tellurium 1240. Iodine 1241. Bromine 1242. Chlorine 1243. Fluorine 1244. Oxygen 1245. Nitrogen 1246. Carbon 1247. Silicon 1248. Boron 1249. Phosphorus 1250. Sulfur 1251. Selenium 1252. Tellurium 1253. Molybdenum 1254. Vanadium 1255. Chromium 1256. Manganese 1257. Iron 1258. Cobalt 1259. Nickel 1260. Copper 1261. Zinc 1262. Cadmium 1263. Barium 1264. Strontium 1265. Calcium 1266. Magnesium 1267. Potassium 1268. Sodium 1269. Lithium 1270. Rubidium 1271. Cesium 1272. Francium 1273. Actinium 1274. Thorium 1275. Radium 1276. Polonium 1277. Astatine 1278. Tellurium 1279. Iodine 1280. Bromine 1281. Chlorine 1282. Fluorine 1283. Oxygen 1284. Nitrogen 1285. Carbon 1286. Silicon 1287. Boron 1288. Phosphorus 1289. Sulfur 1290. Selenium 1291. Tellurium 1292. Molybdenum 1293. Vanadium 1294. Chromium 1295. Manganese 1296. Iron 1297. Cobalt 1298. Nickel 1299. Copper 1300. Zinc 1301. Cadmium 1302. Barium 1303. Strontium 1304. Calcium 1305. Magnesium 1306. Potassium 1307. Sodium 1308. Lithium 1309. Rubidium 1310. Cesium 1311. Francium 1312. Actinium 1313. Thorium 1314. Radium 1315. Polonium 1316. Astatine 1317. Tellurium 1318. Iodine 1319. Bromine 1320. Chlorine 1321. Fluorine 1322. Oxygen 1323. Nitrogen 1324. Carbon 1325. Silicon 1326. Boron 1327. Phosphorus 1328. Sulfur 1329. Selenium 1330. Tellurium 1331. Molybdenum 1332. Vanadium 1333. Chromium 1334. Manganese 1335. Iron 1336. Cobalt 1337. Nickel 1338. Copper 1339. Zinc 1340. Cadmium 1341. Barium 1342. Strontium 1343. Calcium 1344. Magnesium 1345. Potassium 1346. Sodium 1347. Lithium 1348. Rubidium 1349. Cesium 1350. Francium 1351. Actinium 1352. Thorium 1353. Radium 1354. Polonium 1355. Astatine 1356. Tellurium 1357. Iodine 1358. Bromine 1359. Chlorine 1360. Fluorine 1361. Oxygen 1362. Nitrogen 1363. Carbon 1364. Silicon 1365. Boron 1366. Phosphorus 1367. Sulfur 1368. Selenium 1369. Tellurium 1370. Molybdenum 1371. Vanadium 1372. Chromium 1373. Manganese 1374. Iron 1375. Cobalt 1376. Nickel 1377. Copper 1378. Zinc 1379. Cadmium 1380. Barium 1381. Strontium 1382. Calcium 1383. Magnesium 1384. Potassium 1385. Sodium 1386. Lithium 1387. Rubidium 1388. Cesium 1389. Francium 1390. Actinium 1391. Thorium 1392. Radium 1393. Polonium 1394. Astatine 1395. Tellurium 1396. Iodine 1397. Bromine 1398. Chlorine 1399. Fluorine 1400. Oxygen 1401. Nitrogen 1402. Carbon 1403. Silicon 1404. Boron 1405. Phosphorus 1406. Sulfur 1407. Selenium 1408. Tellurium 1409. Molybdenum 1410. Vanadium 1411. Chromium 1412. Manganese 1413. Iron 1414. Cobalt 1415. Nickel 1416. Copper 1417. Zinc 1418. Cadmium 1419. Barium 1420. Strontium 1421. Calcium 1422. Magnesium 1423. Potassium 1424. Sodium 1425. Lithium 1426. Rubidium 1427. Cesium 1428. Francium 1429. Actinium 1430. Thorium 1431. Radium 1432. Polonium 1433. Astatine 1434. Tellurium 1435. Iodine 1436. Bromine 1437. Chlorine 1438. Fluorine 1439. Oxygen 1440. Nitrogen 1441. Carbon 1442. Silicon 1443. Boron 1444. Phosphorus 1445. Sulfur 1446. Selenium 1447. Tellurium 1448. Molybdenum 1449. Vanadium 1450. Chromium 1451. Manganese 1452. Iron 1453. Cobalt 1454. Nickel 1455. Copper 1456. Zinc 1457. Cadmium 1458. Barium 1459. Strontium 1460. Calcium 1461. Magnesium 1462. Potassium 1463. Sodium 1464. Lithium 1465. Rubidium 1466. Cesium 1467. Francium 1468. Actinium 1469. Thorium 1470. Radium 1471. Polonium 1472. Astatine 1473. Tellurium 1474. Iodine 1475. Bromine 1476. Chlorine 1477. Fluorine 1478. Oxygen 1479. Nitrogen 1480. Carbon 1481. Silicon 1482. Boron 1483. Phosphorus 1484. Sulfur 1485. Selenium 1486. Tellurium 1487. Molybdenum 1488. Vanadium 1489. Chromium 1490. Manganese 1491. Iron 1492. Cobalt 1493. Nickel 1494. Copper 1495. Zinc 1496. Cadmium 1497. Barium 1498. Strontium 1499. Calcium 1500. Magnesium 1501. Potassium 1502. Sodium 1503. Lithium 1504. Rubidium 1505. Cesium 1506. Francium 1507. Actinium 1508. Thorium 1509. Radium 1510. Polonium 1511. Astatine 1512. Tellurium 1513. Iodine 1514. Bromine 1515. Chlorine 1516. Fluorine 1517. Oxygen 1518. Nitrogen 1519. Carbon 1520. Silicon 1521. Boron 1522. Phosphorus 1523. Sulfur 1524. Selenium 1525. Tellurium 1526. Molybdenum 1527. Vanadium 1528. Chromium 1529. Manganese 1530. Iron 1531. Cobalt 1532. Nickel 1533. Copper 1534. Zinc 1535. Cadmium 1536. Barium 1537. Strontium 1538. Calcium 1539. Magnesium 1540. Potassium 1541. Sodium 1542. Lithium 1543. Rubidium 1544. Cesium 1545. Francium 1546. Actinium 1547. Thorium 1548. Radium 1549. Polonium 1550. Astatine 1551. Tellurium 1552. Iodine 1553. Bromine 1554. Chlorine 1555. Fluorine 1556. Oxygen 1557. Nitrogen 1558. Carbon 1559. Silicon 1560. Boron 1561. Phosphorus 1562. Sulfur 1563. Selenium 1564. Tellurium 1565. Molybdenum 1566. Vanadium 1567. Chromium 1568. Manganese 1569. Iron 1570. Cobalt 1571. Nickel 1572. Copper 1573. Zinc 1574. Cadmium 1575. Barium 1576. Strontium 1577. Calcium 1578. Magnesium 1579. Potassium 1580. Sodium 1581. Lithium 1582. Rubidium 1583. Cesium 1584. Francium 1585. Actinium 1586. Thorium 1587. Radium 1588. Polonium 1589. Astatine 1590. Tellurium 1591. Iodine 1592. Bromine 1593. Chlorine 1594. Fluorine 1595. Oxygen 1596. Nitrogen 1597. Carbon 1598. Silicon 1599. Boron 1600. Phosphorus 1601. Sulfur 1602. Selenium 1603. Tellurium 1604. Molybdenum 1605. Vanadium 1606. Chromium 1607. Manganese 1608. Iron 1609. Cobalt 1610. Nickel 1611. Copper 1612. Zinc 1613. Cadmium 1614. Barium 1615. Strontium 1616. Calcium 1617. Magnesium 1618. Potassium 1619. Sodium 1620. Lithium 1621. Rubidium 1622. Cesium 1623. Francium 1624. Actinium 1625. Thorium 1626. Radium 1627. Polonium 1628. Astatine 1629. Tellurium 1630. Iodine 1631. Bromine 1632. Chlorine 1633. Fluorine 1634. Oxygen 1635. Nitrogen 1636. Carbon 1637. Silicon 1638. Boron 1639. Phosphorus 1640. Sulfur 1641. Selenium 1642. Tellurium 1643. Molybdenum 1644. Vanadium 1645. Chromium 1646. Manganese 1647. Iron 1648. Cobalt 1649. Nickel 1650. Copper 1651. Zinc 1652. Cadmium 1653. Barium 1654. Strontium 1655. Calcium 1656. Magnesium 1657. Potassium 1658. Sodium 1659. Lithium 1660. Rubidium 1661. Cesium 1662. Francium 1663. Actinium 1664. Thorium 1665. Radium 1666. Polonium 1667. Astatine 1668. Tellurium 1669. Iodine 1670. Bromine 1671. Chlorine 1672. Fluorine 1673. Oxygen 1674.